Microwave Imaging Tomography Using Arrays of Dielectric Resonator Antennas Modeled by Infinitesimal Dipoles

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Current imaging modalities include X-ray mammography, which is the most reliable and most widely used method, ultrasound tomography, diffuse optical tomography (DOT), magnetic resonance imaging (MRI), and others. It is important to emphasize that imaging modalities currently used have inevitable rate of false alarms, which necessitates advancing complementary modalities such that when one modality fails to detect the tumor another modality will succeed. Using complementary methods will increase detection rates and decrease false alarms, saving unnecessary operations and trauma for many women. A promising imaging method has shown a potential to complement the use of ionizing X-ray for breast cancer detection; it is known as the *microwave imaging modality* as published by several researchers; Hagness, Li, Fear, Stuchly, Meaney, Paulsen and others.

The investigators are proposing to develop a novel compact antenna array based microwave imaging system for breast cancer detection that involves the use of dielectric resonator sensors (DR). The dielectric resonator antenna can be designed in small compact size, which is considered a significant advantage to design an array of sensors to fit around the breast for detecting smaller tumors for the early detection of breast cancer. Due to their compact size, high efficiency and wideband frequency range; using the DR sensors will lead to implement novel imaging system. Each antenna element will be used as a transmitter once while all other elements will be used as receivers. The transmitting antenna will be electronically rotated around the breast to illuminate the breast from multiple views.

In this work, we will use several infinitesimal dipoles to model the array of dielectric resonators. This model has been tested and shown good agreement with the actual antenna near and far fields (S. Mikki and Ahmed Kishk, 2006). The model of the new sensor will be used to generate synthetic data of waves scattered from a simplified breast model consists of a tumor immersed in lossy medium. Several imaging algorithms will be examined to reconstruct the shape and location of the tumor. The proposed imaging algorithms are based on using optimization methods such as the Quantum Particle Swarm Optimization (QPSO) technique (S. Mikki and Ahmed Kishk, 2005), the Evolution Algorithm (P. Rashidi, M. El-Shenawee, and D. Macías 2005], and the Steepest Descent Gradient method [M. El-Shenawee and E. Miller, 2005].

A comparison between the above algorithms based on efficiency and robustness will be investigated in this work.